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Omaha District

Papillion Creek and Tributaries Lakes, Nebraska

Site 11 Sedimentation Studies Area-Capacity Report

Glenn Cunningham Lake
Omaha, Nebraska

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M.R.D. Sediment Memoranda

No. 7

SYNOPSIS

This report documents changes in the storage capacity of Papillion Creek Site 11 (Glen Cunningham Lake) from 1976 to 1987.

Storage capacities below the Flood Control and Multipurpose Pool levels were found to have decreased by 560 and 443 acre-feet, respectively. Averaged over the 11-year survey interval, this represented average annual depletion rates of 10.6 and 40.3 acre-feet per year, or to a combined average annual total depletion rate of 50.9 acre-feet. Total percent depletions for the two zones amounted to 0.83% and 11.96%, respectively.

The 50.9 acre-feet per year rate was found to be higher than the 100-year estimated average annual depletion rate of 36.7 acre-feet per year initially reported in DM MPC-35, dated November 1975. However, this rate is not out of line with the longer term rate considering the occurrences of above normal rainfall during several years from 1976 to 1987, the higher rates of sediment inflow expected during such conditions, and the increased rates of sediment inflow that should be resulting from urbanization within the basin. The 50.9 acre-feet rate is well below the 84 acre-feet average annual rate projected for years of peak urbanization and taken into account in the initial design estimates of project storage requirements.

INTRODUCTION

Background - Papio Site 11 is located at 93rd and State Street in Northern Douglas County, Nebraska, near Omaha on Knight Creek, a tributary of Little Papillion Creek (see Plates 1 and 2). A rolled earth dam, the structure is 1,940 feet long, 67 feet high, and contains 656,000 cubic yards of embankment. The drainage area is 17.8 square miles, with a reservoir length of 2.5 miles. Date of initial fill was September 2, 1977. See Table 1 for additional information on the dam and reservoir.

Resurveys - Two complete resurveys have been performed since the original survey in 1976. These were completed in 1982 and 1987.

Purpose - The purpose of this study is to document the change in reservoir capacity from 1976 to 1987.

Authorization - This report was prepared under requirements of EM 1110-2-4000, Reservoir Sedimentation Investigations, and DM MPC-35, Proposed Sedimentation Investiagations, Site 11; and also in partial response to public concerns that storage capacity within the lake is depleting at a rate faster than initially projected.

PROCEDURE

Original reservoir surface areas for 5-foot incremental elevations were planimetered in segments (an area bounded by consecutive or adjacent range lines) from a topographic map produced by photogrammetric methods from aerial photos taken December 5, 1970. Elevations ranged from 1090 to 1155 feet m.s.l. The planimetered data and cross section data were run through various programs as follows:

a. The cross-section data for 1976 and 1987 were run through a scanning and sorting program (SCASO) to add missing end station data, scan the data for any repetitions data or data found out of order, sort data by range and by station, and add header cards. Following processing through SCASO, data for both years were plotted together and compared to locate discrepancies and errors. Any data entry errors found were corrected and the cross sections replotted.

b. Planimetered surface areas were run through the program BPOINT4, with the output listed as volume by segments at incremental elevations.

c. Corrected cross-section data for both years were run through the hydraulic elements program (SHELEM). The hydraulic elements program calculated each cross-section's area, average depth and bed elevation, and average width for an incremental series of water surface elevations.

d. The next program in the series was the volume-ratio program (VOLRAT). First, original volumes (BPOINT4) output) and 1976 SHELEM output were input to VOLRAT. The output provided ratios of volume to cross-section areas in each segment for each 5 feet of elevation (these computed ratios are to be used for all resurveys). Then, 1987 output from SHELEM and the constant ratios by elevation were input to VOLRAT. Output was the 1987 volumes by segments.

e. VOLRAT output was modified and used in the water and sediment volumes table program (WASTAB). WASTAB computed and tabulated water volumes for the entire reservoir for both the 1976 and 1987 surveys. Also calculated and

TABLE 1

SUMMARY OF ENGINEERING DATA
PAPIO SITE 11

ITEM NO.	SUBJECT	DAM NO. 11 (Glenn Cunningham Lake)	
	GENERAL		
1	Location of dam	93rd State Street	
2	River and mileage	Knight Creek —	
3	Drainage area (sq. mi.)	17.8	
4	Reservoir length in miles	2.5	
5	Location of Damtender	None	
6	Travel time to Missouri River	5-10 Hours	
7	Max. discharge of record	—	
8	Project cost (1)	$11,800,000	
	DAM AND EMBANKMENT		
9	Top of dam — ft. MSL	1152	
10	Length of dam — ft.	1940	
11	Height of dam — ft.	67	
12	Stream bed — ft. MSL	1085	
13	Abutment formation	Lean clay loess	
14	Type of fill	Rolled earth	
15	Fill quantity in cu. yds.	656,000	
16	Date of closure	5 Aug 1974	
17	Date of initial fill	2 Sep 1977	
	SPILLWAY		
	Discharge capacity — cfs (max. pool)	18,700	
	Crest elev. — ft. MSL	1142	
	Width — ft.	700	
	Gates, number, size, type	Ungated earth channel	
	RESERVOIR ELEV. AND AREA		
22	Maximum pool	1147	1170a.
23	Top of flood control pool	1142	991a.
24	Top of multipurpose pool	1121	377a.
	STORAGE ZONES (Elev.-Capacity)		
25	Surcharge	1142-1147	5,405AF
26	Flood control	1121-1142	13,899AF
27	Multipurpose	1085-1121	3,262AF
28	Gross storage (Excl. of surcharge)		17,161AF
	OUTLET WORKS		
29	Number and size — conduits	1 — RCP — 54'' diameter	
30	Conduit length — ft.	680	
31	Discharge capacity of conduit — CFS (at top of F.C. Pool)	570	
32	Gated outlets (No. — size — invert elev. of intake in ft. MSL)	1 — 30''x 30''	1100
33	Discharge capacity of gated outlets — CFS (at base of F.C. Pool)	90	
34	Ungated outlets (No. — size — invert elev. — ft. MSL)	2 — 2.0'x 4.0'	1121
		2 — 2.5'x 9.0'	1127.5
35	POWER INSTALLATION	None	

tabulated were volume sediment deposition (or scour) between the two survey years for each reservoir segment and accumulated sediment volume for the reservoir.

f. VOLSURA, a program that computes volumes at one-foot intervals was run next, using a portion of WASTAB's output of the 1976 and 1987 data as input.

g. The final program in the series, CAPAC, permitted a printout of the area-capacity values in a final tabular form. VOLSURA output was used as input. CAPAC produced the tables shown in Appendix A.

A more detailed discussion of the execution of the above programs can be found in the 1986 Omaha District Area-Capacity Program Manual.

CHANGE IN RESERVOIR CHARACTERISTICS

In 1985 a sediment retention dam (designated as D4) was built west of 96th Street between ranges 22 and 23 (see Plate 2). The reservoir storage lost due to the structure's volume is negligible. Monuments for range 23 could not be found and will be relocated at a later date. Data from 1982 was used for range 23.

SEDIMENT DISTRIBUTION

Distribution of the retained sediment by reservoir depth and length is tabulated on ENG Form 1787, found in Appendix B. Analysis of the depth distribution reveals that ninety percent of the retained sediment has deposited below elevation 1,125 feet m.s.l. This elevation encompasses both the multipurpose pool and the annual high pool (highest pool to date 1124.4). In the longitudinal direction, it appears that the sediment is fairly uniformly deposited from the dam to the Highway 36 bridge, a distance of approximately 1.8 miles or 62 percent of the multipurpose pool length. While only about one-fourth of the original reservoir volume was located upstream of this bridge, more than one-third of the retained sediment has deposited above it.

RESULTS

Tables 2 and 3 are comparisons of 1976 and 1987 reservoir elevations vs. area and reservoir elevation vs. capacity for various pool levels and storage zones.

TABLE 2
Reservoir Surface Area by Elevation

Reservoir Elevation	Surface Area (in acres)	
	1976	1987
Maximum Pool (elev. 1147)	1,171	1,170*
Top of flood control pool (elev. 1142)	991	991
Top of multipurpose pool (elev. 1121)	395	377

* The one acre loss between 1976 & 1987 is likely due to survey error and/or computation rounding.

TABLE 3
Reservoir Capacity by Storage Zone

Storage Zone	Elevation	Capacity (acre-feet)		Change
		1976	1987	1976-1987
Surcharge	1142-1147	5,404	5,405	+ 1
Flood Control	1121-1142	14,016	13,899	-117
Multipurpose	1085-1121	3,705	3,262	-443

In Design Memorandum No. MPC-35, dated November 1975, the 100-year estimated average sediment depletion rate was 36.7 acre-feet per year, with a range of 84 acre-feet per year during urbanization to 9 acre-feet per year after urbanization.

Excluding the surcharge zone, the measured sediment depletion rate from 1976 to 1987 averages 50.9 acre-feet per year or a total of 560.0 acre-feet. The higher than predicted average depletion rate was most likely caused by higher than normal rainfall for the period 1976 to 1987 and some urbanization. Although construction is not as great near the reservoir as earlier predicted, some new homes have been constructed and a housing development is in its early stages.

Storage below the multipurpose pool decreased from 3,705 acre-feet in 1976 to 3,262 acre-feet in 1987. This represents a 11.96 percent decrease in 11 years or 40.3 acre-feet per year.

The surface area for the top of the multipurpose zone has decreased at a rate of 1.6 acres per year. See Table 4 for acres lost and percentage lost at various depths.

TABLE 4
SURFACE AREA REMAINING - PAPIO DAM SITE 11

Year	Depth in Feet Below Multi-purpose Pool						
	0	1	5	10	15	20	25
1976 (acres)	395	369	269	159	84	35	8
1987 (acres)	377	350	248	140	67	23	0
1987 (% remaining)	95	95	92	88	80	66	0

SUMMARY

Gross storage, excluding the surcharge zone, decreased from a 1976 volume of 17,721 acre-feet to a 1987 volume of 17,161 acre-feet. This represents a 3.2 percent decrease in 11 years or 50.9 acre-feet per year.